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EXCITATION SYSTEMS FOR SYNCHRONOUS MACHINES

MAIN ABOUT EXCITATION SYSTEMS

Excitation systems, controlled by microprocessor voltage regulator type DARP, are based on Institute's own hardware and software solutions. The development is based on over 80 years of activities on the area of electronics and regulation and 30 years of applying microprocessor digital control technology. Excitation systems manufactured in the Institute are operating in over 50 generators.

Excitation systems are produced for synchronous generating units in termal and hydro power plants of different capacities from couple of kW, up to several hundreds of MW.
Excitation systems are also produced for synchronous motors in different industrial facilities.

EXCITATION SYSTEM TYPES

Excitation systems can be of different type:
- AC type excitation systems
- DC type excitation systems
- Static excitation systems
- Brushless excitation systems

Now the most popular type are static excitation systems for medium and large generators and brushless excitation systems for small and medium generators.

Static excitation systems are intended mainly for synchronous generators larger than 1 MVA and field currents from 100 A up to 7000 A DC.
The supply of the main excitation system power circuit is realized over excitation transformer connected to main generator outputs (self-excitation connection) or form some other AC auxiliary source (independent or external excitation) and thyristor converter in fully controllable six pulse bridge configuration. Cooling of power electronic stage can be natural (up to 1000A DC field current) or forced air cooling or forced water cooling.

Brushless excitation systems are intended mainly for synchronous generators from several hundred kW up to 50MVA and field currents from 5 A up to 100 A DC.
Generating unit with brushless excitation system has auxiliary AC exciter machine with rotating three-phase winding and diode bridge. The exciter field winding is on the stator side.
The supply of the exciter field winding is realized over power stage of the AVR from excitation transformer connected to main generator outputs (self-excitation connection), from PMG mounted on generator shaft or form some other AC auxiliary source (independent or external excitation). AVR power stage can be transistor or thyristor rectifier.

AVR for brushless excitation system, Ifn = 12A

DIGITAL VOLTAGE REGULATOR - DARP

Voltage regulator type DARP is realized as modular.
DARP hardware is based on 32-bit microprocessor, while the software support is realized according to all relevant standards for excitation systems.

BASIC CHARACHERISTICS:
- Two-channel thyristor converter configuration
- Two-channel regulator configuration
- Three phase generator current and voltage measuring
- Sampling of measuring variables via signal processor
- Extension of digital and analogue input and output signals
- Measuring and logging data with resolution up to 10 kHz
- HMI panel

ADDITIONAL FUNCTIONS:
- Possibility of additional functions via software modules, without additional hardware

Voltage regulator | Voltage regulator
Dual channel option

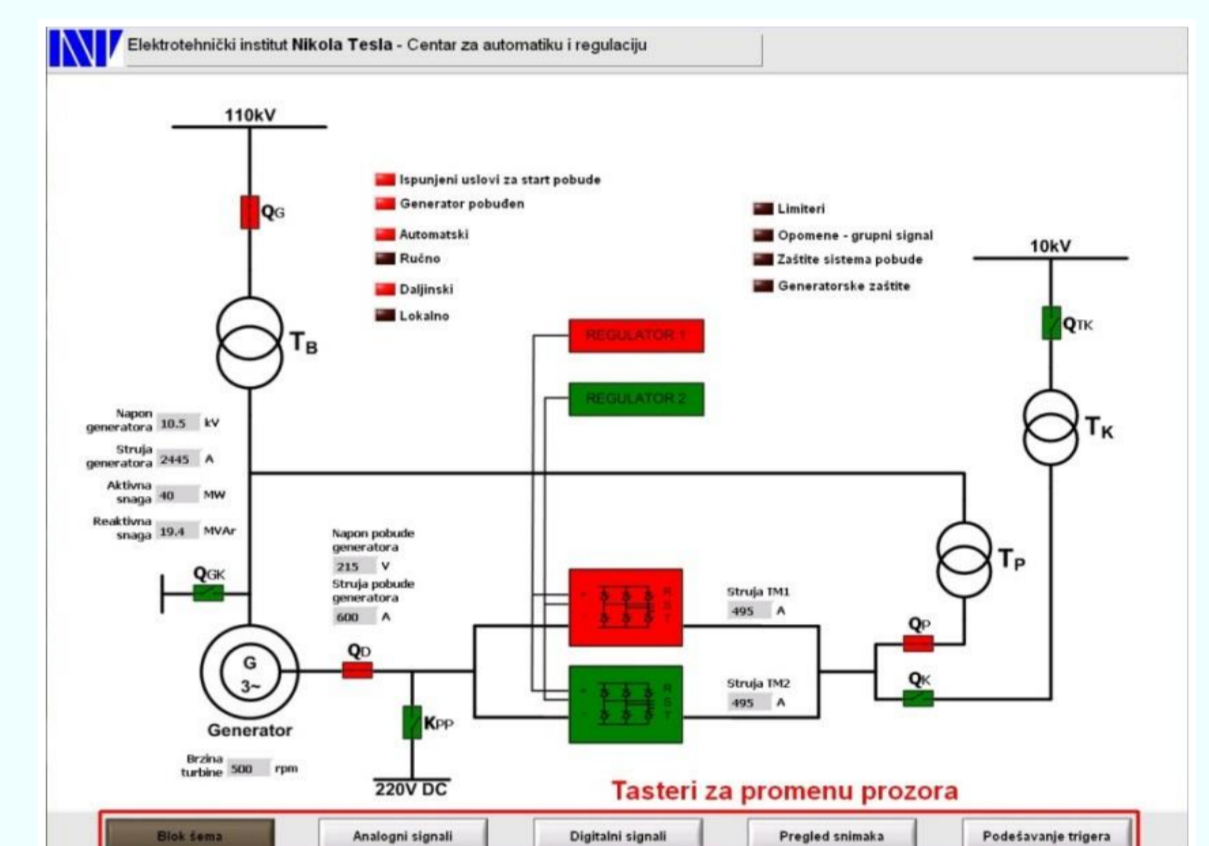**HPP Djerdap 2, 10x27MW, If = 2110A**

TPP Morava, 150MVA, If = 1575A
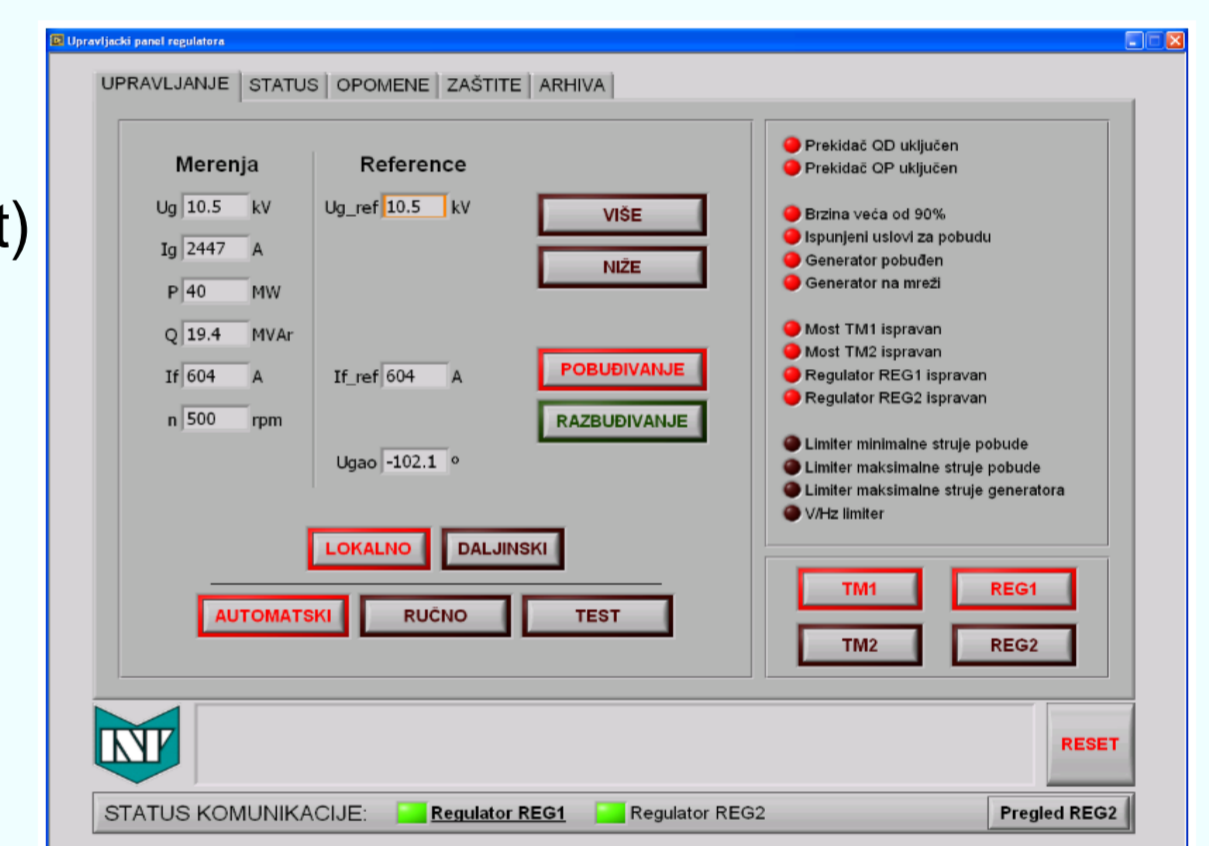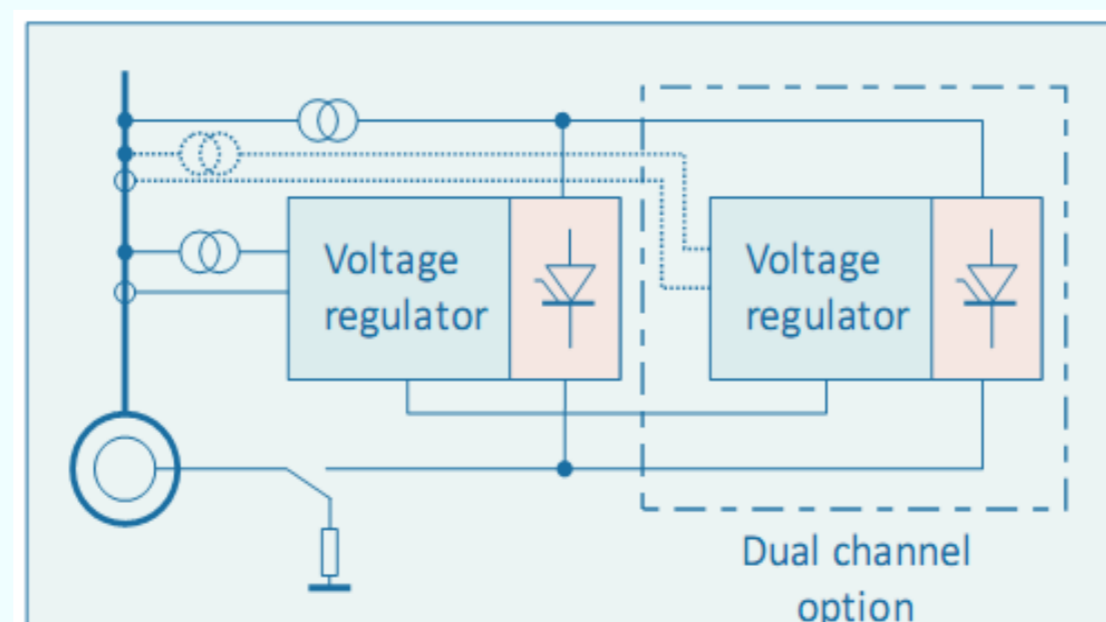
AVR SOFTWARE SUPPORT

BASIC FUNCTIONS:
- Generator voltae regulator (PI type)
- Field current regulator (PI type)
- Limiters
  - Maximal field current
  - Under-excitation
  - Maximal stator current
  - V/Hz
- Compensation per generator current
- Compensation per generator frequency
- Automatic follow-up
- Logical and sequential operation
- Integration into the plant control system
- Monitoring and self diagnostic
- Data acquisition system
- Communication protocols (Serial and/or Ethernet)

ADDITIONAL FUNCTIONS:
- Power system stabilizer PSS2B
- Q regulator
- cosφ regulator

REFERENCES

- Static excitation systems of units A1 (210MW), A2 (210MW) and A6 (348.5MW) in TPP "Nikola Tesla A", Obrenovac
- Electro-machine excitation systems of units A3, A4 and A5 (3 x 308MW) in TPP "Nikola Tesla A", Obrenovac
- Static excitation systems of units B1 (348MW) and B2 (348MW) in TPP "Kostolac B", Drmno
- Static excitation systems of unit A1 (110MW) in TPP "Kostolac A", Kostolac
- Reconstruction of electro-machine excitation system of unit A5 (110MW) in TPP "Kolubara A", Veliki Crljeni
- Reconstruction of electro-machine excitation system (120MW) in TPP "Morava", Svilajnac
- Static excitation systems of units A and B (2x11.25MW) in HPP "Kokin Brod", Kokin Brod
- Static excitation systems of units A, B and C (3x18MW) in HPP "Potpeć", Priboj
- Static excitation systems of units A and B (2x54MW) in HPP "Bistrica", Bistrica
- Static excitation systems of units A1 and A2 (2x3.2 + 2x5.3MW) in HPP "Ovčar Banja" and HPP "Međuvršje", Čačak
- Static excitation systems of units A1 and A2 (2x55.25MW) in HPP "Bočac", Republika Srpska, BIH
- Static excitation systems of units A1 and A2 (2x16MVA) in HPP "Vrla I", Surdulica
- Static excitation systems of units A and B (14+15.75MVA) in HPP "Vrla II", Surdulica
- Static excitation systems of units B1 and B2 (667,5MW + 680MW) in TPP "Nikola Tesla B", Obrenovac

$$I_{fnom} = 6518A \; / \; U_{fnom} = 685V$$

- Static excitation systems of units A3, A4, A5 and A6 (4x27MW) in HPP "Djerdap II", Negotin
- Static excitation systems of units A and B (14+15.75MVA) in HPP "Vrla IV", Surdulica
- Static excitation systems of units A1 and A2 (2x14.3MW) in Pump Station "Lisina", Surdulica
- Static excitation systems of units A1, A2, A7 and A8 (4x27MW) in HPP "Djerdap II", Negotin
- Static excitation system of generator 353MVA in TPP "Gacko", BiH
- Static excitation system of generator 353MVA in TPP "Ugljevik", BiH
- Static excitation system of unit A3 (89MVA) in TPP "Kolubara", Veliki Crljeni
- Static excitation systems of units A3 and A4 (2x15.75MVA) in HPP "Vrla I", Surdulica
- Static excitation systems of units A1 and A2 (16+18.6MVA) in HPP "Vrla III", Surdulica
- Static excitation systems of units A1 (10MVA) in HPP "Trebinje 2", BIH
- Static excitation systems of units A1 and A2 (2x44,5MVA) in HPP "Pirot", Pirot